

**Description of age 0 juvenile pugnose
minnow *Opsopoeodus emiliae* (Hay) and
pugnose shiner *Notropis anogenus* Forbes
in Ontario**

J.K. Leslie and C.A. Timmins

Great Lakes Laboratory for Fisheries and Aquatic
Sciences
867 Lakeshore Road
Burlington, Ontario L7R 4A6

2002

**Canadian Technical Report of Fisheries
and Aquatic Sciences 2397**

Canadian Technical Report of Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1-456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. Numbers 457-714 were issued as Department of the Environment, Fisheries and Marine Service, Research and Development Directorate Technical Reports. Numbers 715-924 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Technical reports are produced regionally but are numbered nationally. Request for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport technique canadien des sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère de Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la revue *Résumé des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annuel des publications scientifiques et techniques du Ministère.

Les numéros 1 à 456 de cette série ont été publiés à titre de rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Les rapports techniques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Canadian Technical Report of
Fisheries and Aquatic Sciences 2397

2002

Description of age 0 juvenile pugnose minnow *Opsopoeodus emiliae* (Hay)
and pugnose shiner *Notropis anogenus* Forbes in Ontario

By

J.K. Leslie and C.A. Timmins

Department of Fisheries and Oceans
Great Lakes Laboratory for Fisheries and Aquatic Sciences
867 Lakeshore Road
Burlington, Ontario L7R 4A6

©Minister of Supply and Services Canada 2002
Cat. No. Fs 97-6/2397E ISSN 0706-6457

Correct citation for this publication:

Leslie, J.K., and C.A. Timmins. 2002. Description of age 0 juvenile pugnose minnow *Opsopoeodus emiliae* (Hay) and pugnose shiner *Notropis anogenus* Forbes in Ontario. Can. Tech. Rep. Fish. Aquat. Sci. 2397.

ABSTRACT

Leslie, J.K., and C.A. Timmins. 2002. Description of age 0 juvenile pugnose minnow *Opsopoeodus emiliae* (Hay) and pugnose shiner *Notropis anogenus* Forbes in Ontario. Can. Tech. Rept. Fish Aquat Sci. 2397.

Age 0 juvenile pugnose shiner *Notropis anogenus* Forbes and pugnose minnow *Opsopoeodus emiliae* (Hay), collected in the Lake St. Clair-Detroit River ecosystem, are described for morphologic, morphometric, meristic, and pigmentary characteristics. Both fishes have a black lateral stripe extending from snout to caudal fin, and a small, terminal, sharply oblique mouth. Combined, these characters distinguish the pugnose fishes from other cyprinids. The pugnose shiner has modal values of 23 preanal and 13 postanal myomeres, 8 rays in the median fins, and dark peritoneum. The pugnose minnow has 22 preanal, 14 postanal myomeres, 8 anal and 9 dorsal fin rays. The peritoneum is pale and pigmentation is lighter than on the shiner. These fishes have restricted distribution and are classified "vulnerable" in Canada.

RÉSUMÉ

Leslie, J.K. and C.A. Timmins, 2002. Description of age 0 juvenile pugnose minnow *Opsopoeodus emiliae* (Hay) and pugnose shiner *Notropis anogenus* Forbes in Ontario. Can. Tech. Rept. Fish Aquat Sci. 2397.

Des spécimens de ménés camus *Notropis anogenus* Forbes et de petits-becs *Opsopoeodus emiliae* (Hay) d'âge 0, capturés dans l'écosystème du lac Sainte-Claire/rivière Détroit, sont décrits pour leurs caractéristiques morphologiques, morphométriques, méristiques et pigmentaires. Les deux poissons possèdent une bande latérale foncée allant du museau à la nageoire caudale, ainsi qu'une petite bouche terminale nettement oblique. Ensemble, ces traits distinguent ces espèces des autres cyprinidés. Le méné camus possède 23 myomères pré-anaux et 13 myomères post-anaux, 8 rayons sur les nageoires médianes et un péritoine foncé. Le petit-bec possède 22 myomères pré-anaux, 14 myomères post-anaux, 8 rayons de nageoire anale et 9 rayons de nageoire dorsale. Le péritoine est pâle et la pigmentation est plus claire que celle du méné. Ces espèces ont une distribution restreinte et sont classées "vulnérables" au Canada.



INTRODUCTION

The pugnose minnow *Opsopoeodus emiliae* (Hay) and the pugnose shiner *Notropis anogenus* Forbes are native Canadian cyprinids recorded in specific drainages of Lake St. Clair-Detroit River, and Lake Erie (Mandrak and Crossman 1992). The pugnose shiner has been found in several additional locales in the upper St. Lawrence River (Carlson 1997). Elsewhere in North America these species occur mainly in the Gulf states and the Mississippi River Valley (Scott and Crossman 1973). Rare and restricted geographically, they are without legal protection and presently classified in Canada as "vulnerable" (Campbell 2001).

Pugnose minnows prefer low gradient, clear streams and embayments with abundant rooted vegetation (Scott and Crossman 1973). Although this fish is known in Ontario from 10 localities, Parker et al. (1987a) found just 8 specimens in the Sydenham River watershed in 1980. The pugnose shiner also prefers abundant macrophytes in moderately turbid water. However, recent surveys (Timmins, unpublished data 1995) confirm Gerking's observations (Trautman 1981), i.e., pugnose shiners occasionally frequent shallow turbid water devoid of vegetation.

Bailey (1959) described the general morphology and distribution of adult pugnose shiners, and Parker et al. (1987a,b) summarised geographical information on both "pugnose" fishes in Canada. However, systematists have scant information on physiology, behaviour, and ecology of these species, and early life history stages have not been described. We presume that lack of interest in the pugnose fishes stems from the low bioeconomic importance accorded them. Herein, we fill an information gap by describing juvenile age 0 fishes of both species, and compare them with cyprinids of similar morphology and pigmentation.

Study areas

Pugnose shiners and pugnose minnows were both found near the mouth of the Canard River (42° 10' 30"N; 83° 05' 00"W), a polluted, low gradient tributary to the Detroit River (Fig. 1). A constant high load of suspended sediments prevents development of extensive submersed macrophytes in the Canard River. However, sparse stands of pondweeds *Potamogeton* spp., wild celery *Vallisneria americana*, and Eurasian water milfoil *Myriophyllum spicatum* prevail at the shore in the lower reach. Cattails *Typha* spp., bulrushes *Scirpus* spp., and American lotus *Nelumbo lutea* represent dominant emergent plants. The substrate in the lower reach consists

primarily of alluvium. Because of sporadic and restricted occurrence and absence of larvae, neither fish species was considered to have utilised the Canard River for spawning or as nursery habitat.

Adult pugnose shiners were also found in Long Point inner bay ($42^{\circ} 37'N$; $80^{\circ} 10'W$) in early May and age 0 juveniles in mid-September, 1985 (Leslie and Timmins 1997). Most common macrophytes in this shallow bay include stonewort *Chara vulgaris*, Eurasian water milfoil, wild celery, pondweed *Potamogeton freeissii*, and naiad *Najas flexilis*. Cattail *Typha latifolia*, spike rush *Eleocharis elliptica*, and sedges *Carex* spp., are common emergent plants in the inner bay.



Fig. 1. Age 0 juvenile pugnose shiners used in this study were collected in Mitchell Bay (x), and pugnose minnows in the Canard River (o), southwestern Ontario.

Whereas few pugnose minnows were caught in the Canard River in 1994-95, numerous pugnose shiners were collected at a vegetated sampling site in Mitchell Bay, Lake St. Clair (Leslie

and Timmins 1993). Mitchell Bay (42° 28'N; 82° 25'W) is situated at the east side of the St. Clair River delta (Fig. 1). It is uniformly shallow (depth 1-2 m) with a mid-summer canopy of submersed macrophytes dominated by stonewort, Eurasian water milfoil, and wild celery. Common emergent plants include spike rush, bulrush, and cattails. The assemblage of fish larvae formed a clupeid-atherinid-cyprinid-centrarchid complex. Although sites at the shore and open water were sampled, pugnose shiners were found almost exclusively in dense submersed macrophytes.

MATERIALS and METHODS

Collection methods were the same at all locations. A bulging larval fish beach seine (4-m long, 1-m wide, 0.3-mm mesh opening) was hauled at a depth of ~1.0 m parallel to shore. Fishes were "fixed" with 5-10% formalin, identified, and stored in a 12:1 mixture of 70-80% ethanol and glycerine.

Linear measurements of body parts <5 mm were accurate to ± 0.02 mm, whereas parts >5 mm were accurate to ± 0.2 mm. Morphometrics were determined with the aid of an ocular micrometer on a dissecting microscope. Body depth factor (BDF) and caudal depth factor (CDF) were determined to indicate general body form and swimming ability. Body depth factor is defined as mean total length $\div$ mean body depth, whereas CDF = mean caudal peduncle depth $\div$ mean body depth. Mean fish volume = mean total length $\times$ (mean body depth)² (Webb and Weihs 1986). Methods and terms describing morphologic characteristics follow Trautman (1981). Voucher fish are maintained at the Great Lakes Laboratory for Fisheries and Aquatic Sciences, Burlington, Ontario.

DESCRIPTIONS

The pugnose minnow and the pugnose shiner, two of Canada's smallest cyprinids, have been found only south of 46 degrees latitude, southern Ontario (Mandrak and Crossman 1992). Superficially alike in appearance, these taxa have a small terminal, oblique mouth, a single, soft-rayed dorsal fin, and a homocercal caudal fin. Both species have a black lateral stripe from snout to caudal fin base.

Opsopoeodus emiliae (Hay)

The pugnose minnow is a phytophil and as such, deposits adhesive eggs on live or dead submersed vegetation or branches, but "never on the bottom" (Balon 1975). Temperature at which spawning first occurs is unknown. According to mean total length (TL) in September-October and assumed linear growth from hatch (~5 mm), spawning may take place in mid-June, when submersed vegetation is usually well established and water temperature is at least 15°C. The pugnose minnow attains maximum length of about 50 mm (Scott and Crossman 1973). Specimens in the Canard River ranged from 20 to 51 mm TL, and were collected on 10 dates from July to October.

Morphology

Age 0 juveniles have a blunt ("pug") snout with a small, oblique mouth. The anus is situated in mid-body. Premaxillaries are protractile, the jaws articulate below the margin of the anterior nare, and the opening of the terminal mouth follows a horizontal line through the centre of the eye. There are two air bladders and the filiform body is fully scaled. The series of canals on lateral line scales is interrupted at a vertical below the middle of the dorsal fin. The peritoneum is light.

The pectoral fins originate low on the body, the origin of the pelvic fin slightly precedes the origin of the dorsal fin, and the deeply forked caudal fin has pointed lobes (Fig. 2). Pelvic and anal fins are pointed. The depressed pectoral fins extend to mid-body, the depressed pelvic fins usually extend to the anterior margin of the anus, the depressed dorsal fin to the anal fin insertion, and the depressed anal fin to about mid-peduncle.

Morphometry and meristics

Morphometric and meristic characters for juvenile pugnose minnows (20-30 mm TL) are given in Table 1. Mean myomere counts were 22.1 (preanal), 14.1 (postanal), and 36.2 (total). Snout length averaged 23% (21-26%) head length (HL), and eye diameter 34% HL. The anal and dorsal fin bases were 7.9% and 10.1% TL, respectively, and mean lengths of the pectoral and pelvic fins were 12.6% (3.5 ± 0.6 mm) and 11.5% TL (3.2 ± 0.5 mm), respectively.

Pigmentation

The lower lip and premaxillaries had a few faint spots; the chin was barren. The snout and interorbital area had a blotch of fine spots. The cheek was clear and the opercle bore a light patch of melanophores. A dark, heart-shaped patch was expressed on the occiput. The isthmus, thorax, and gut were barren. A body-long lateral stripe originated on the snout and extended to the caudal peduncle, the stripe slightly wider posteriorly (Fig.2). Larger juveniles exhibited a continuous, dark stripe. Small (20-24 mm) fish had a small black spot at the side of the anus.

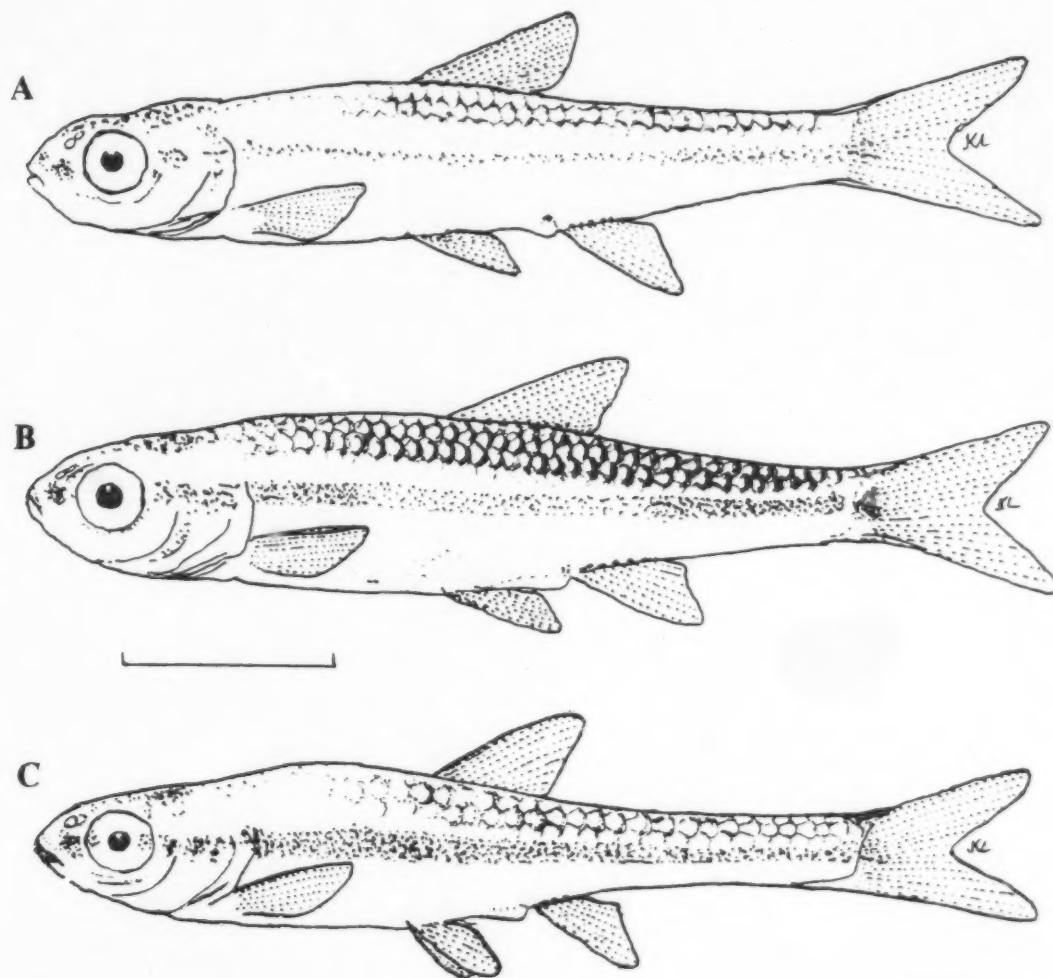


Fig. 2. Age 0 pugnose minnow (A), pugnose shiner (B), and blackchin shiner (C). These fishes (24 mm TL) were collected in southwestern Ontario. Length bar = 5 mm.

Fins were transparent and, except for several median rays at the base of the caudal fin, margins of fin rays were immaculate. Melanophores were rare or absent both above and below the median body stripe. The anal fin base was darkly pigmented. A ventral series of small spots occurred from the anal fin insertion to the end of the caudal peduncle. The margin of scales was lightly pigmented on the dorsolateral and dorsal body surfaces.

Notropis anogenus Forbes

The pugnose shiner usually occurs in vegetated areas of low gradient streams and clear waters of small lakes and is extremely intolerant of turbid conditions (Trautman 1981). Nevertheless, it may temporarily frequent turbid lowland streams, such as the Canard River. The pugnose shiner is a lithophil - a nonguarding, open substratum spawner. Eggs of lithophils are laid on rock, rubble, or gravel bottom (Balon (1975). Embryos hatch early, without cement glands, and are highly photophobic. Spawning probably occurs in early to mid-June, when various forms of submersed plants are developed. In Canada, maximum length of this fish is about 50 mm (Scott and Crossman 1973). Fish in Mitchell Bay were collected as adults in April and May, and as larvae or juveniles from June to September.

Morphology

General body form, relative position of dorsal and pelvic fins, location of anus, and mouth size separate this fish from 15 shiners in Ontario waters of the Great Lakes basin. In lateral profile, an age 0 juvenile is slender and symmetrical, the anus is situated near mid-body, the origin of the pelvic fins is slightly anterior to the origin of the dorsal fin, and the mouth is terminal (Fig. 2).

Maximum body depth and width are located at the dorsal origin. The peritoneum is dark. Large eyes dominate the head; the small mouth is terminal, sharply oblique, and opens on a horizontal line with the upper half of the pupil. The premaxillaries are protractile. The upper jaw is slightly included within the lower jaw. Jaws articulate below a vertical from the margin of the anterior nares. Squamation was complete on smallest specimens (~18 mm).

The moderately pointed pectoral fins are located low on the body and extend midway between the gut and base of the pelvic fin. Pelvic fins are sharply rounded and extend to the posterior margin of the anus. When depressed, the anal fin extends just beyond mid-peduncle. The

depressed dorsal fin extends to a vertical line through the anal fin insertion. The caudal fin is homocercal, with sharply rounded lobes and deep fork.

Morphometry and meristics

Myomeres (21-24 preanal, 12-14 postanal, 35-38 total) are listed as modal values in Table 1 for specimens ranging from 18 to 30 mm TL. Snout length, eye diameter, and postorbital length were 21%, 34%, and 45% HL, respectively. There were 3 branchiostegal rays. Pre and post-dorsal fin scales on the dorsal ridge were spaced irregularly. The dorsal fin base was 9.5% TL and the anal fin base 8.5% TL. Pectoral and pelvic fin lengths were 13.0% (4.0 ± 0.5 mm) and 12.8% TL (3.9 ± 0.5 mm), respectively.

Table 1. Morphometry and meristics for juvenile age 0 *Notropis anogenus* and *Opsopoeodus emiliae*. Mean length ($\pm$ SD) and % TL (**in bold**) are shown for each character. N = number of measurements. Myomere and fin ray values are modal; range in parentheses.

Character	<i>Notropis anogenus</i>				<i>Opsopoeodus emiliae</i>			
Length				N				N
Mean TL $\pm$ SD	24.1	4.4 mm		56	26.0	2.7 mm		22
Standard	19.2	3.3	79.7	54	20.7	2.1	79.6	22
Preanal	12.8	2.2	53.1	44	13.3	1.4	51.2	22
Prepelvic	9.5	1.9	39.4	22	10.0	1.1	37.4	22
Predorsal	10.2	1.6	42.3	56	10.3	1.3	39.6	22
Head	4.9	0.7	20.3	56	5.2	0.5	20.0	22
Eye	1.7	0.3	7.1	52	1.8	0.2	6.9	22
Body depth	4.2	1.0	17.4	56	4.2	0.6	16.2	22
Peduncle depth	1.9	0.4	7.9	44	2.0	0.3	7.7	22
Myomeres								
Preanal	23	(21-24)		53	22	(21-23)		48
Postanal	13	(12-14)		53	14	(14-15)		48
Total	37	(35-38)		53	36	(35-38)		48
Fin rays								
Dorsal	8			48	9			33
Anal	8			48	8			22
Pelvic	8			47	8			22
Pectoral	12	(12-14)		12	13	(13-14)		30
Caudal	19			12	19			22
Scales								
Predorsal	14	(13-16)		24	15	(13-17)		35
Postdorsal	16	(14-18)		24	16	(13-17)		34
Lateral line	38	(36-38)		6	37	(36-38)		6
Caudal depth factor	0.44			44	0.47			22
Body depth factor	5.70			44	6.16			22
Volume (mm³)	431			56	463			22

Pigmentation

The lower lip of the pugnose shiner was dark, and the chin faintly pigmented or clear. The snout had a lateral cluster of small dark melanophores. A prominent body-long mid-lateral stripe from snout to caudal fin was not expressed through the eyes (Fig. 2). A narrow clear space separated the stripe from a black triangular basicaudal spot. Pigment below the lateral stripe was sparse or absent.

A dark heart-shaped patch on the occiput contrasted with sparse pigment on the snout and interorbital area. Melanophores covered the dorsal body surface between the nape and base of the caudal fin. A faint, thin line of spots extended along the dorsal ridge from nape to mid-caudal peduncle. Melanophores on scale margins were wider and more concentrated on the peduncle than on the anterior dorsum. The margin of the anus, the base of the anal fin, and an indistinct postanal double line constituted the sole pigmentation on the ventral aspect.

All fins were transparent. Margins of dorsal fin rays bore dashes, whereas melanophores appeared only on the margin of the first few dorsal rays of the pectoral and pelvic fins. Rays of the anal and caudal fins were lightly pigmented, while membranes were clear. Black melanophores marked edges of lateral line pores.

DISCUSSION

An extremely small mouth is the single character that most distinguishes the pugnose minnow and pugnose shiner and separates them from other age 0 juvenile cyprinids. Except for a difference of one ray in the dorsal fin, morphometric and meristic characters of both species are the same or lie within ranges (Table 1). Few subtle differences in morphology of the pugnose shiner, e.g., a less rounded snout, greater body depth, and slightly longer predorsal length were insufficient to distinguish it from the minnow. With slightly smaller body depth, the pugnose minnow is perhaps physiologically better adapted than the shiner to the periphery of marginal vegetation, and shallow open water. Generally, pigmentation is expressed more on the shiner than on the minnow, with a darker mid-lateral stripe, presence of a thin mid-dorsal stripe, a dark caudal spot, and wider dark margins on the dorsal scales. In addition, the peritoneum is dark in pugnose shiners and light in pugnose minnows. The "flattened" eye of pugnose minnow larvae (Fuiman et

al. 1983) and two dusky areas on the dorsal fin of adults (Trautman 1981) were not present in age 0 juveniles.

The pugnose shiner most resembles the blackchin shiner *Notropis heterodon* (Fig. 2). These species have similar pigmentation, modal myomere counts, and a mid-lateral stripe (Leslie and Timmins 2000). Like the pugnose shiner, the blackchin shiner has a thin, faint, mid-dorsal stripe, but the peritoneum is pale, the chin is black, and the snout pointed (Fig. 2). The blacknose shiner *Notropis heterolepis* bears close resemblance to the pugnose minnow but has a larger, slightly subterminal mouth, 8 dorsal fin rays, and 20 preanal myomeres (Leslie and Timmins 2000). To reiterate, the main distinguishing feature of the pugnose fishes is a small, terminal, sharply oblique mouth.

Preanal myomere counts for nine cyprinids fall within the range for age 0 juvenile pugnose minnows and pugnose shiners (Fuiman et al 1983). However, most of these species lack the mid-lateral stripe or have one or two features not shared with the pugnose fishes. For example, the spottail shiner *Notropis hudsonius* (light peritoneum) and the bluntnose minnow *Pimephales notatus* (black peritoneum) have a subterminal mouth and a prominent black basicaudal spot. The bluntnose minnow has 7 rays in the anal fin and crowded predorsal scales. Golden shiner *Notemigonus crysoleucas* has a lateral stripe, a small oblique mouth, sharply pointed snout, decurved lateral line, and more than 8 rays in the anal fin. The mimic shiner *Notropis volucellus* and the sand shiner *Notropis stramineus* resemble the pugnose minnow, although the sand shiner has 7 rays in the anal fin and 8 in the dorsal fin, whilst the mimic shiner usually has 9 pelvic fin rays and 15 pectoral fin rays. There is no stripe on the snout of the mimic shiner (Houston 1996) and neither shiner has a small, vertical mouth. The fathead minnow *Pimephales promelas* has a mid-lateral stripe, a stout body, 7 rays in the anal fin, but no caudal spot. These diagnostic characters should rapidly separate sympatric cyprinids. Of the above species, only the golden shiner is commonly found in habitat usually utilised by the pugnose fishes.

Reproductive strategies of cyprinids often separate larval stages according to ecotope, whilst age 0 juvenile fishes are frequently syntopic. The presence of one taxon may strongly indicate the presence of another, as observed in sheltered habitats of the Thousand Islands in the St. Lawrence River, where blackchin shiners and pugnose shiners co-occurred (Carlson 1997). These species also co-occurred in Long Point, Lake Erie, but not in densely vegetated Hog Bay, southeastern Lake Huron, where the blackchin shiner dominated cyprinid larvae (Leslie and Timmins 1995;

1997). Because pugnose minnows have been found on numerous occasions in relatively clear waters of the Detroit River and tend to avoid siltation, we consider their presence in turbid Canard River unusual.

Whereas pugnose minnows were found in an area devoid of vegetation, pugnose shiners only utilised dense vegetation in sand. Wild celery, Eurasian water milfoil, and stonewort, and three emergents: cattails, bulrushes, sedges, were common to all locations where pugnose shiners were recorded. Although these fishes have been collected in few locales, their environmental requirements appear to be met in many coastal enclaves of the Lake St. Clair-Lake Erie ecosystem, if not in lakes Huron and Ontario. However, present fragmented populations of the pugnose shiner and the pugnose minnow probably lack connectivity between sanctuaries separated by extensive stretches of exposed, featureless coastline. Lack of field data since early human settlement hinders our understanding of changes in geographic distribution of these fishes in Ontario waters.

Human resource extraction continues to rapidly modify and destroy fish habitat in southern Ontario, as it did in the Ohio flatlands (Trautman 1981). The pugnose shiner and the pugnose minnow are environmentally sensitive, and are thus useful indicators of the quality and status of water bodies and fish habitats. A fish unknown is a fish endangered. Thus, extensive, systematic field surveys are needed to determine critical habitat requirements and geographic range of these vulnerable species. Studies of reproductive activities are necessary, as are taxonomic descriptions of larvae.

REFERENCES

- Bailey, R.M. 1959. Distribution of the American cyprinid fish *Notropis anogenus*. *Copeia* 1959(2): 119-123.
- Balon, E.K. 1975. Reproductive guilds of fishes: a proposal and definition. *J. Fish. Res. Board Can.* 32: 821-864.
- Campbell, R.R. 2001. Rare and endangered fishes and marine mammals of Canada: COSEWIC Fish and Marine Mammal Subcommittee Reports: XIII. *Can. Field-Nat.* 115: 115-117.
- Carlson, D.M. 1997. Status of the pugnose and blackchin shiners in the St. Lawrence River in New York, 1993-1995. *J. Freshw. Ecol.* 12: 131-139.
- Fuiman, L.A., and five co-authors. 1983. State of the art of identification for cyprinid fish larvae

- from eastern North America. Trans. Am. Fish. Soc. 112: 319-332.
- Houston, J. 1996. The status of the blackchin shiner, *Notropis heterodon*, in Canada. Can. Field-Nat. 110: 483-488.
- Leslie, J.K., and C.A. Timmins. 1993. Distribution, density, and growth of young-of-the-year fishes in Mitchell Bay, Lake St. Clair. Can. J. Zool. 71: 1153-1160.
- Leslie, J.K., and C.A. Timmins. 1995. Abundance and spatio-temporal distribution of young-of-the-year fishes in an altered embayment of Lake Huron. Water Qual. Res. J. Canada 30: 713-732.
- Leslie, J.K., and C.A. Timmins. 1997. Early life history of fishes in Long Point inner bay, Lake Erie. Can. Tech. Rep. Fish. Aquat. Sci. 2150: 18 p.
- Leslie, J.K., and C.A. Timmins. 2000. Contribution to taxonomy of age 0 *Notropis heterodon* (Cope) and *Notropis heterolepis* (Eigenmann & Eigenmann). Can. Tech. Rep. Fish. Aquat. Sci. 2321: 14 p.
- Mandrak, N.E., and E.J. Crossman. 1992. A checklist of Ontario freshwater fishes. Royal Ont. Museum. Toronto. 176 p.
- Parker, B., P. McKee, and R.R. Campbell. 1987a. Status of the Pugnose Minnow, *Notropis emiliae*, in Canada. Can. Field-Nat. 101: 208-212.
- Parker, B., P. McKee, and R.R. Campbell. 1987b. Status of the Pugnose Shiner, *Notropis anogenus*, in Canada. Can. Field-Nat. 101: 203-207.
- Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Bull. Fish. Res. Board Can. 184: 966 p.
- Trautman, M.B. 1981. The fishes of Ohio. Ohio State Univ. Press, Columbus, Ohio. 782 p.
- Webb, P.W., and D. Weihs. 1986. Functional locomotor morphology of early life stages of fishes. Trans. Am. Fish. Soc. 115: 115-127.